ARMY RESEARCH LABORATORY

Distance Learning: Overview and Recommendations for the ARL MSRC PET Training Program

by Mary Bea Walker

ARL-CR-512 December 2002

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Contents

1. Introduction

In education, true innovations are rare. Whether by using a stick to draw in the dust, a wax tablet and stylus, or a blackboard and chalk, most learning events have occurred face to face and with similar tools since instructors started teaching students.

With the ascent of the computer as both a repository and a delivery mode for information and training, millions* of educators and learners throughout the world are experiencing a revolutionary break from traditional face-to-face, delivery methods. This author directed distance education by electronic blackboard, videotape, and live satellite uplink for the College of Engineering at the University of Illinois at Urbana-Champaign (UIUC). She observed that learners rarely asked questions and were generally passive, even when given the opportunity to participate. With their built-in support for collaborative interaction and communications, computer-based learning methodologies are changing passivity into proactivity.

Online learning systems support and encourage learner communications. Students can ask questions electronically, then absorb and digest replies at their own speed. Timid students are not left in the shadow of more aggressive or assertive ones. Instructors have varied mechanisms for giving direct feedback to the student without a formal meeting. Online course coordinators can assist the confused and the dissatisfied with confidentiality. Online learning is changing the social interaction of today's classroom environment. This can empower the instructor, the learner, and the training coordinator—according to the Carl Rogers book title [2]—with freedom to learn.

This report gives a very brief overview† of some of the terms and methods for Internet-based distance learning, considers trends relayed by experts in the field of government, industry, and academia, and makes recommendations to the U.S. Army Research Laboratory (ARL) Major Shared Resource Command (MSRC)

* One software tool discussed in this report is WebCT. "It is used in institutions throughout the world and is a leading provider of integrated e-learning systems. Over 148,000 faculty members at more than 1,700 colleges and universities are using WebCT's products and services to transform the educational experience for more than 5.8 million students ... in 10 major world languages" [1].

† Thousands of articles exist on distance learning technologies and more appear daily. This author attended a recent distance learning event and received a handout of 99 Internet-based resource sites, each with many links. The handout stated, "Over the last several months, networks of interrelated online education resource sites have developed across the Internet. These are articles with educational articles, sites with courses or course-support material, and sites with lists of additional resource links" [3].

Programming Environment and Training (PET) program concerning the use of distance learning methodologies to deliver training for its high-performance computing (HPC) users across the country.

Engineers and scientists want to hone their professional skills by continuing to learn, but often lack the time and the opportunity to do so. Work demands often do not allow them to travel and then sit for hours or days in a classroom. Because of advances in distance learning, courses can come to professionals' offices and workstations so they can learn independently and at their own pace.

2. Distance Learning Defined

The term "distance learning" has existed since the days of correspondence courses by courier and by mail. Correspondence study guides and audiotapes were overtaken by instructional television, videotapes, diskettes, compact disks, and video teleconferencing. While these continue to be used, there is a vast movement towards learning online over the Internet.* This report addresses this type.

To clarify terms, Internet-delivered instruction can either be (1) synchronous (i.e., simultaneous live interaction with others online in real time over the Internet), (2) asynchronous (from Latin and Greek: *a* = not + *sun* = same + *chronos* = time) where students and instructor are not in the same place at the same point in real time, or (3) a combination of the two.

If the learning event is delivered in an asynchronous delivery mode, the student can take the course at his/her own pace and time. (Such a course is produced using one of many software packages on the market.) With a synchronous course, the student can interact with the instructor and/or fellow students just as they would in a live class, even though the student may be logged onto it from another geographic area. Both ways have advantages, but experts agree that traditional classroom instruction will continue to have great merit. One such group weighed today's educational and social realities and decided:

* Sometimes "Internet" and "World Wide Web" are used interchangeably. "They can be defined as: (1) Internet (with an uppercase "I") is the vast collection of interconnected networks that all use the TCP [Transmission Control Protocol]/IP [Internet Protocol] protocols and that evolved from the [Advanced Research Projects Agency Network] ARPANET of the late 1960s and early 1970s, (2) an "internet" (with a lower case "i") is any [set of] computers connected to each other (i.e., a network), and are not part of the Internet unless they use TCP/IP protocols [4], and (3) "Internet" refers to all the resources and users on the Internet that are using the Hypertext Transfer Protocol (HTTP). A broader definition comes from Web inventor Tim Berners-Lee and the World Wide Web Consortium: 'The World Wide Web is the universe of network-accessible information, an embodiment of human knowledge'" [5].

> It is our view that the traditional model of an instructor and students present in the same time and space provides the best quality of education because of the almost unbounded modes of communication and interactivity made possible by physical presence. However, changing lifestyles and more demanding schedules are forcing more and more students to reap the benefits of academic instruction remotely and the attendant demand for distance education is growing exponentially . . . . Increasingly powerful communication and information technologies have opened the way for enhancing traditional teaching and learning in both distance and conventional education using synchronous and asynchronous tools [6].

3. Value of Online Distance Learning

In January 1999, President Clinton signed Executive Order (EO) 13111 establishing the President's Task Force on Federal Training Technology. It directs federal agencies to enhance employee training opportunities through the use of technology, and it created an advisory committee of major agencies (the Departments of State, Treasury, Defense, and 19 others) to facilitate this. This EO directed that a technology resource center be established "to support federal agencies using training technology and to facilitate the development of online training courses" [7].

The U.S. Office of Personnel Management (USOPM), the federal government's human resource lead, has a training management and assistance (TMA) branch that attests that it custom designs courses for most any topic, to be delivered in a classroom setting or at the desktop workstation, and produced in any manner, including CD-ROM and Web-based training [7]. They indicate that they have developed thousands of training programs, and USOPM certainly knows how federal government employees want courses delivered.

There is also a Federal Government Distance Learning Association (FGDLA) to promote related practices within the federal government. It coordinates with the Government Alliance for Training and Education (GATE), which develops strategic plans for implementing distance learning in government agencies. FGDLA and GATE sponsor the Telecons, a series of distance technology conferences throughout the U.S. The ARL PET team attended Telecon East in Washington, DC, in March 2000.

The business world is enthusiastic about distance learning possibilities. A number of the National Center for Supercomputing Applications' (NCSA's) major Fortune 500 industrial partners are working with NCSA and experts from

UIUC to gain in-depth knowledge of aspects of new distance learning technologies and their appropriate use. One of these persons is this author.*

The Vice President of the Technical and Educational Products at an Indianapolis, IN, firm says, "Company CEOs are becoming very interested in the fact that (through online learning) they may not have to fly people around to get to a class." A New York City partner in a law firm dealing with large corporation states, "You have a sales force . . . with a minimum amount of time to spend offsite and who desire the flexibility to meld education into their own schedules. Online learning simply makes sense." The Division Vice President of the Professional Insurance Agents in Alexandria, VA, adds, "There is a definite need for other delivery methods of educational programming." Her association believes that one-third to one-half of all educational programs for professionals in its field will be online within the next few years [8].

In academia, "online teaching is a fact of life on college campuses—especially off them" [9]. According to a U.S. Department of Education survey covering the 1997–1998 academic year, 1.4 million students were enrolled in college-level credit-granting distance education courses.

Most U.S. public and private universities offer distance education courses [10]. Some have very large programs, e.g., the University of Maryland has 21,000 students and 550 Web-based courses; the University of Phoenix has 61,000 students and 6,000 faculty. Private enterprise is implementing distance education in a major way. For example: Motorola University had 30,000 students and a faculty of 1,500. Virtual-campus consortia are growing up rapidly, such as the Phare Project where 11 European countries are establishing 40 regional centers [11]. Many more international students are enrolled in noncredit adults and continuing education courses around the world. Despite this rapid growth, many agree online instruction is still in its infancy.

A noted professor and Associate Dean says, "Everyone in higher education has to get on this technology bandwagon . . . . The alternative would be equivalent to a teacher at the turn of the century refusing to use books . . . . We are just beginning to explore the countless ways to use technology for things traditionally done in other ways" [12].

Whatever the source, the funding connected with online learning is phenomenal. "Online learning is currently generating $600 million in annual revenues and is expected to exceed $10 billion by 2002" [13].

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* The author is a Ph.D., Ed.D., NCSA Senior Research Scientist and Senior Academic Lead for Training for the ARL MSRC PET Program and works with NCSA, College of Education, and other colleagues on this topic.

4. Considerations

Software abounds to help organizations and individuals create and support online education courses. What might be best for ARL PET training? In just one review article on comparative analysis of software for course creating and support (commonly called "courseware"), 55 different products, each with a Web link, were counted. There are dozens more such products for full or for partial support of online courses and systems.

The author and the ARL PET team attended a conference at the University of Maryland and benefited from an extensive exercise in comparative processes to aid in choosing distance learning software. The workshop leader had time to fully detail only four of many applications for an international audience in a room filled to capacity, standing room only. These software products were CourseInfo, Learning Space, Top Class, and WebCT. Twenty pages exist on the specifications and abilities of these systems; more can be found on their Web sites.

In late 1999, the author met with local Center for Educational Technologies (CET) members whose mission it is to help faculty develop online courses on the UIUC campus. This center trains and provides consulting services, and in several iterations, first-hand knowledge was gained of CET-supported courseware.

UIUC CET supports the following selected courseware: Web-based threaded conferencing tools (FirstClass, WebBoard) and course management systems (CourseInfo, WebCT, and Mallard). CET indicates CourseInfo is a "tool to help you transition from traditional teaching methods to online course methods without learning HTML" and explains that Mallard was "developed at the University of Illinois [and] allows instructors to develop sophisticated quizzes, surveys, and course material." CET goes on to say that WebCT can "create entire online courses and [is] praised for its extensive set of tools and features" [14].

The range of sophistication of these systems is quite varied. Some are simple Web-based conferencing systems. Others are more powerful and are whole-course management systems that help the instructor and his/her technical support create learning environments, e.g., synchronous and/or asynchronous online communications (bulletin boards, chat rooms, e-mail) between and among students and instructor, homework details and links, student exams and progress tracking, file management, and security. Some systems are simple to learn and use. CourseInfo can be used after one session with a knowledgeable CET professional and a manual. However, this particular courseware would not support complex engineering- and science-course development needs. Others, like Mallard and WebCT, are more comprehensive and have greater capability,

but are correspondingly more difficult to use. Earlier, the author took a short course and update in WebCT with other professionals.

5. Considerations Concerning Distance Learning and HPC Training

"As regards the more advanced activities in which computer-based 'courseware' replaces university lecturing completely, successful examples are rare. Reasons postulated include the lack of suitable courseware, lack of time and staff to develop new materials, and lack of faculty and administrative support to do so" [15].

Creating a course with the sufficient courseware needed for an advanced engineering or science topic can be difficult and very time consuming. Many educational institutions allow eight months to one year for course development. This is not simply the instructor's time spent writing lectures, exams, and homework assignments into the chosen course management system. Many schools require courseware training for the professors and then have them practice and work with an experienced mentor throughout the production and delivery of their courses. Online courses also need consultants skilled in instructional design who are knowledgeable about the chosen courseware and are valuable resources to the instructor.

Technical support persons are also needed to put the course online and to maintain its accurate and continuous functioning while the course is being offered. Because of the early state-of-the-art, especially for synchronously delivered courses, this can be a real challenge. Administrative persons are required to enroll students, maintain their records, supply materials, and assist them with the many details that are part of any class.

In a university or college offering courses for academic credit, there are layers of additional issues that ARL PET may or may not have to face regarding distance learning, including ownership of intellectual property rights. To whom does an online course belong? The instructor? The institution (i.e., university, government, or company who provided funding)? Both? What about copyrights, royalties, and reimbursement for onload (part of one's assigned professorial duties) or overload (extra or consultancy) instruction? The author has heard a number of presentations on legal issues brought to light by distance courses that are not simple to resolve.

Since ARL PET online courses would not be offered for academic credit, a very large set of issues can be avoided. These include the entire credit-course approval process (department, college, university and its senate, state board of

higher education of its own and other states). Credit-course issues are numerous, including grading, homework, adequate student feedback, student identification, examinations, and cheating. There are many articles written about challenges and solutions for these matters.

For all institutions involved in online courses, maintaining quality in the teaching-learning transaction is a key issue. Student assessment and evaluation studies number in the thousands, with more coming daily. Most of the literature says that there is no significant difference between regular and online courses* [16]. However, if the traditional and online courses were both mediocre at the outset, the student would still have a less-than-adequate learning experience.

ARL PET has a very specialized adult audience as its customer. These are highly motivated and educated professionals who voluntarily take classes in difficult subject-matter areas to better perform their tasks. They are also very disciplined, and, as many have advanced degrees, are used to teaching themselves how to learn. Because of their work, computers are second nature to these scientists and engineers, so they do not have the same hurdles to overcome as would a larger portion of the potential adult-learning community who do not have these similar computer skills.

Online courses appear to be ideal for the HPC-user audience, and they are, in some cases. Specifically, for entry-level subject-matter areas where a quick overview or review is necessary, such courses are a good choice. However, for advanced subject-matter areas that often exist on the frontiers of knowledge, their information changes so rapidly, online courses that normally take months to develop and are usually delivered over several years to recover costs would no longer be pertinent. Such courses would need constant updating. These constitute much of ARL PET HPC subject-matter areas. Change is the nature and the excitement of HPC, and it is a reason why so much training is needed by the scientists and engineers who require HPC resources to further their research.

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* "In doing research in distance and online learning, we have found it to be just as effective, or more effective, as classroom training. [However] some things don't translate into an online environment, particularly material that requires a significant 'hands-on' application, with a strong emphasis on peer review and collaboration. Yet, the unarguable upside of online learning . . . is [that it is] much more cost-effective, requires no travel time, and does not result in any lost productivity. . . . [Our agency's] assessment of online vs. classroom effectiveness, as measured by performance in the workplace following training, has found no significant difference between the two" [17].

6. Recommendations

- Because HPC-related disciplines are changing so quickly, many ARL PET training offerings are conducted face to face by experts from academia, government, and sometimes, by private-sector vendors whose software is the temporary front runner in a dynamic industry. Such courses are usually videotaped by the ARL PET training team and made available to ARL HPC users who request them. Users can readily view what tapes are available from the ARL PET Web pages. These practices—live courses and videotaping—should continue. Live courses are often the preferred mode of ARL PET HPC users and of many in the adult population in general.

  For those who cannot attend due to work constraints, a videotape is often available. ARL PET tapes courses as they are being taught. This practice avoids much post-production cost because there is no major editing of the tapes. Satellite uplink facilities for taping live university courses were set up by the author. Studio production of broadcast-quality videotape courses is very expensive. The way ARL PET tapes courses is quite acceptable to the audience who uses them.

- When live face-to-face courses are not possible, the next alternative preferred by the ARL PET audience is synchronous online courses. There are now selected live courses broadcast over the Internet from the Higher Education and Applied Technology (HEAT) Center in Aberdeen, MD, and sometimes from the ACCESS* Center. Participants can see the instructor in real time on their workstations, ask questions, and save much time and energy by not having to travel to a facility hours away.

  ARL PET is using Tango Interactive for these online courses. It was developed by an ARL PET colleague, Prof. Geoffrey Fox and his staff at Syracuse University.† There have been several versions of Tango with improvements made to each. ARL PET members have attended a number of workshops to keep abreast of current software. Tango requires much attention by technology professionals at the site of origin, receiving sites,

* The National Computational Science Alliance (National Science Foundation [NSF] funded) Center for Collaboration, Science, and Software located in the Washington, DC, metro area. It was established in 1998.

† Tango is a Java-based collaboratory system for the Web, partly sponsored by the U.S. Air Force Rome Laboratory to the Northeast Parallel Architectures Center (NPAC) at Syracuse University, Syracuse, NY. NPAC wanted to build a collaborative software infrastructure and integration framework to use the Web more effectively for cooperative work. One Tango focus is education and distance learning [18].

and by training coordinators before and during a broadcast. This type of technology is still very new and its dependability varies.

(1) ARL PET team members should continue to pursue offering courses by this method and keep up with the technology and knowledge needed to make these online courses available.

(2) If courses are to be broadcast by Tango to any sites but the ones ARL PET presently supports, this should be additionally resourced by ARL PET. For instance, there are no personnel assigned to support Tango at NCSA because NCSA is a testbed, rather than a course-production facility.

- Some ARL PET Computational Technical Area (CTA) leads have expressed interest in creating online courses themselves using WebCT courseware. The author's investigations, as well as those of colleagues at NCSA, UIUC CET, and at major universities in the U.S., show this courseware to be one of the more adequate tools now available for the task. This software field is dynamic and changing quickly. ARL PET offered WebCT training for its members to use when PET had experienced instructors funded by the ARL PET program to use WebCT technology.

(1) To support WebCT online course development and maintenance, the ARL PET team requires more personnel than it presently employs. Instructional design, online creation, administration, and technical support for online courses are labor-intensive activities that require a coordinated team of trained professionals who can be continuously available to instructors and participants. This does not exist presently in ARL PET. These resources should be added to the training team.

(2) Online learning is not going away. ARL PET should make provisions to assist CTA leads who wish to go in the direction of so many of their teaching and professional colleagues, especially in more stable, introductory subject-matter areas. These can be repetitious to the instructor but necessary to the neophyte HPC user. New users can benefit from an online course because they can go directly to the section needed without having to sit through hours of class time to get to the desired information. HPC users, like many other professionals, will grow to expect such courses because of the timeliness and convenience the delivery methodology provides.

- The author recommends that ARL PET team continue to investigate the emerging and highly complex world of synchronous and asynchronous learning methodologies. ARL PET has done so from its inception as a

team, with technologies such as Mbone,* PictureTel,† WebCT, and Tango. As ARL PET's audience is constantly investigating new science and engineering areas, so should the ARL PET team continue to do so for its customers.

ARL PET was one of the coordinators of the very first synchronous, online Tango transmission of the course from the ACCESS Center in Washington, DC. The course was "Java for Scientific Programming," and was offered by ARL PET, NCSA, and the Ohio Supercomputing Center in early 1999 as an experiment. This was before the ACCESS Center had even opened. The course had the largest number of participants a Tango course had had up to that time and it was very successful. There was also a waiting list for the course at the ACCESS Center. Coincidentally, the course took place during an ARL PET midyear review and was reported there by the author.

The ACCESS Center continues to be a showcase for new collaborative learning technologies. An example is the Internet-based Access Grid (AG), developed at Argonne National Laboratory (ANL). The AG home page is <http://www-fp.mcs.anl.gov/fl/accessgrid>). Since 1999, many learning events have been synchronously offered by the 50-member NSF National Computational Science Alliance via the AG. NCSA is the Leading Edge Site for the Alliance. As a 1999 Chautauqua technical forum was broadcast from the ACCESS Center and multiple U.S. sites, ARL PET Training's Computational Summer Science Workshop for high school teachers and students was also taking place at ACCESS. The Chautauqua showcased this ARL PET workshop for its innovation. The ARL PET Training Team was proud to participate in this testbed enterprise. The AG now has some 80 sites (nodes) and enabled a worldwide audience to participate in the 2002 Supercomputing Conference in Denver, CO. For more information on the AG, go to a series of Web-based tutorials at <http://webct.ncsa.uiuc.edu:8900/public/AGIB/>. The author helped develop these with ANL and the Ohio Supercomputing Center.

- The Alliance looks to establish Grid Nodes for synchronous use by HPC and other online customers across the nation. The author and others at

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* This term comes from "multicast backbone on the Internet." "It supports IP multicasting or two-way transmission of data between multiple sites .... The Mbone is an experiment to upgrade the Internet to handle live multimedia messages .... It works fine for static information, such as text and graphics, but it doesn't work well for real-time audio and video." In 1997, there were more than 3,000 Mbone servers on the Internet [19].

† PictureTel provides visual collaboration which includes "such cutting-edge technologies as video streaming, data collaboration, and more. Visual collaboration provides people with full access to the intellectual capital of their organization through both real-time and archived visual content. It provides easy, seamless access to information using traditional switched networks, IP corporate networks and the Internet itself" [20].

NCSA and UIUC are investigating the optimal teaching and learning environment for the Access Grid. They are doing this (1) by studying learning as it relates to present-day on-the-job problem solving in industry, (2) by investigating aspects of the complex psycho-social interactions of collaboration and education over the Internet, (3) by examining the emerging and many-faceted field of knowledge management, and (4) by researching and experimenting with the latest technology for scientific collaboration and training.

(1) ARL PET exists to serve and further research and develop tools for its HPC users. In the interest of its customers, it is imperative that ARL PET stay in the forefront with those who see online distance learning and collaboration as the newly developing backbone of the nation's educational and research system.

(2) Therefore, with colleagues in the NCSA Education, Outreach, and Training (EOT) Division and at UIUC, the author recommends that ARL MSRC PET consider building Access Grid Nodes at selected sites across the nation, and developing a collaboration and training environment that would move video and audio across the Internet in real time, permitting instant discussions, collaborative research (including scientific visualization), experimentation, team development, training, and just-in-time meetings.

7. Conclusion

It is the mission of NCSA's Education, Outreach, and Training (EOT) Division to research tomorrow's educational and training applications by building testbeds for those applications. It would be very appropriate for NCSA EOT to do so with ARL PET, because a number of NCSA EOT members already know the ARL PET program well, having worked with it for several years. These individuals have access to experts and could serve as liaisons between the development- and HPC-user communities, serving them both, and furthering knowledge about pioneering technology and the Internet.

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14. ABSTRACT
This report gives a very brief overview of some of the terms and methods for Internet-based distance learning, considers trends relayed by experts in the field of government, industry, and academia, and makes recommendations to the U.S. Army Research Laboratory Major Shared Resource Command Programming Environment and Training program concerning the use of distance learning methodologies to deliver training for its high-performance computing users across the country.

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